May 1, 1928. 1,668,504

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METHOD OF AND APPARATUS FOR THE CONCENTRATION OR PURIFICATION OF CAUSTIC SODA OR OTHER SUITABLE MATERIAL

Filed Sept. 4, 1926 3 Sheets-Sheet 1

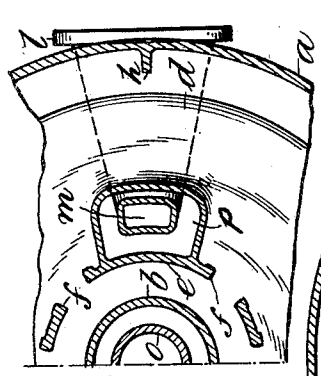


Fig. 3.

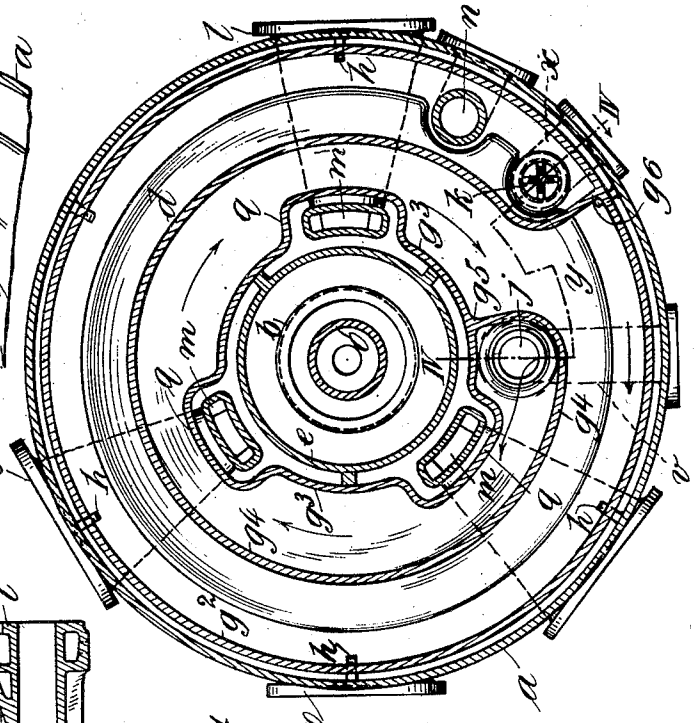


Fig. 2.

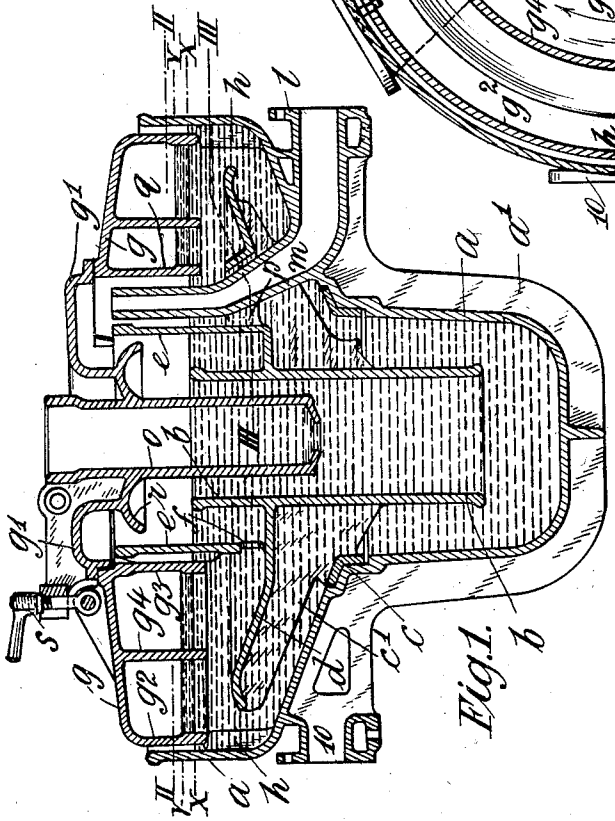


Fig. 1.

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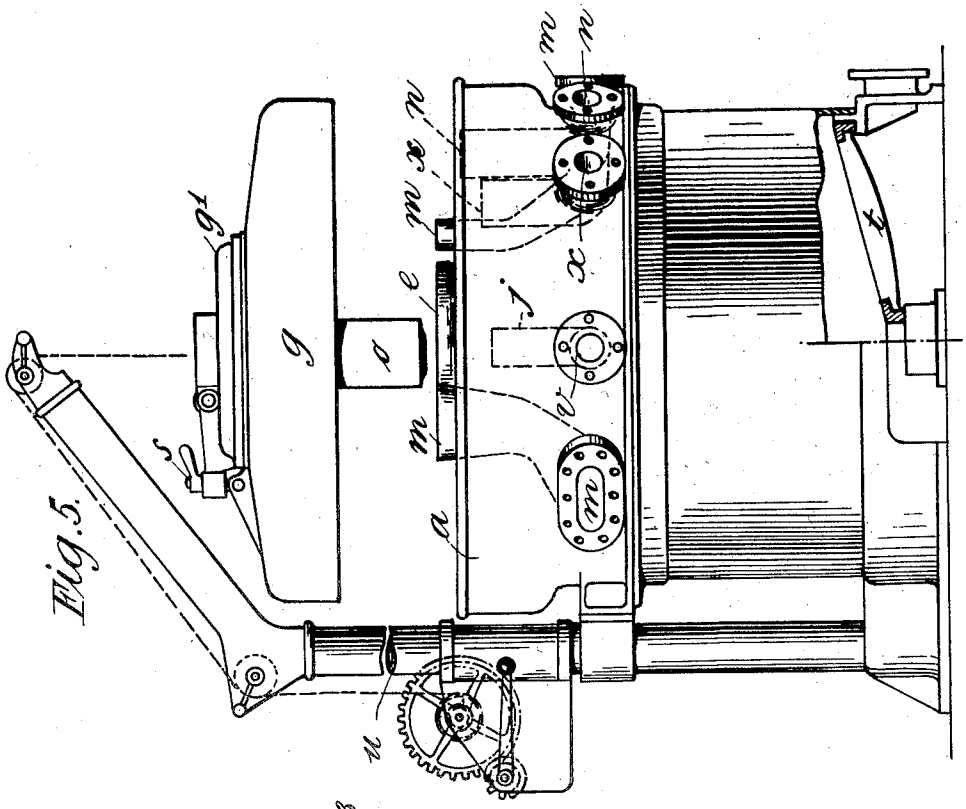


Fig. 5.

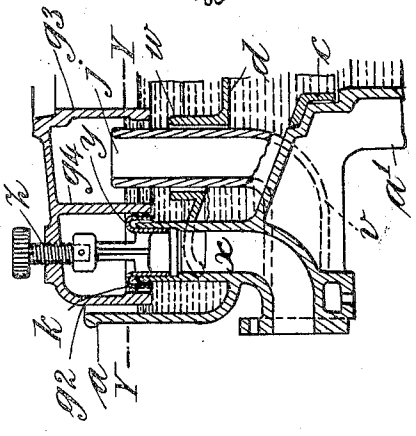


Fig. 4.

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Fig. 6.

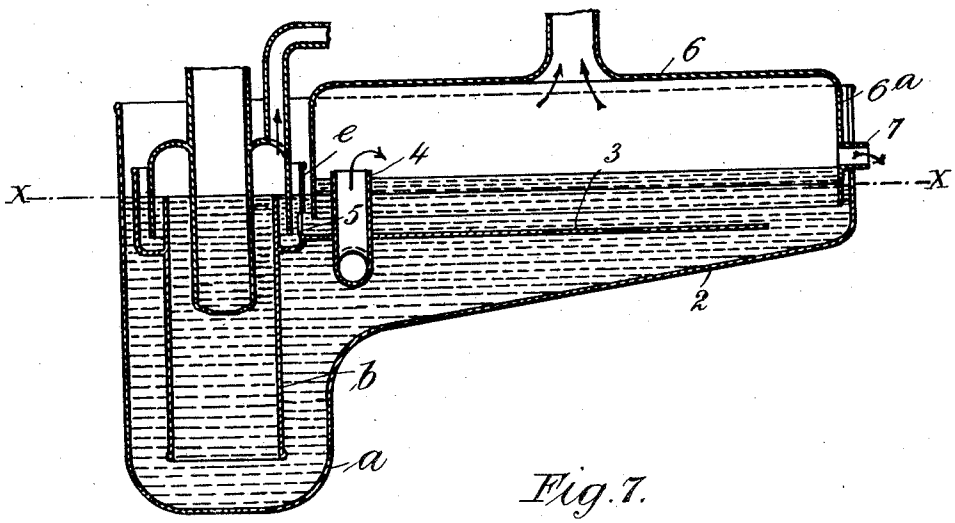
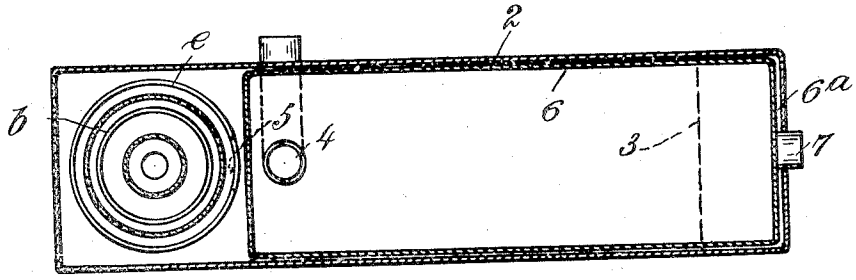


Fig. 7.



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UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR THE CONCENTRATION OR PURIFICATION OF CAUSTIC SODA OR OTHER SUITABLE MATERIAL.

Application filed September 4, 1926, Serial No. 133,681, and in Great Britain September 5, 1925.

This invention relates to a method of and apparatus for performing heat treatments of materials, such heat treatments being involved in the purification, evaporation, concentration, distillation or decomposition of various substances. There are many examples of such heat treatments which can be carried out very advantageously and economically by the aid of the flame of a submerged burner. In carrying out these treatments, it is desirable that the substances treated should not be allowed to come into contact with the products of combustion and it may be desirable also to carry out the treatments under seal or with the treatment material protected against contact with the outside atmosphere.

Substances which may be treated in accordance with this invention include, for example, strong caustic soda solutions, oils, tar or pitch, or solids in the comminuted or powdered form such as sawdust, metalliferous ores, coal, peat, vegetable matter and refuse. In the case of caustic soda solution in particular, it is not possible to concentrate this material by submerging the flame directly in the liquor, because the carbon dioxide present in the products of combustion would immediately convert the caustic soda into sodium carbonate.

According to this invention the material to be treated is conducted over the surface of a hot liquid mass heated directly by the flame or gases of a submerged flame burner, the products of combustion being withdrawn at a portion of the surface which is not covered by the material in the performance of its course over the hot liquid mass. Usually, a bath of molten metal such as lead, or a suitable alloy, will be employed as the hot liquid mass. The space over the molten mass from which the products of combustion are withdrawn is suitably enclosed and sealed against the atmosphere and the material to be treated is advantageously conducted over an elongated, tortuous or circuitous course on the surface of the mass the said course being covered in by a covering sealed by the molten mass against the atmosphere and against the gases of combustion. Provision is made for the removal of steam and vapours liberated from the treated mass so that such vapours may be utilized or by-products may be recovered when desired. In the case of the heat treatment of caustic soda solution, which may be preheated if desired, the water is first driven off and the anhydrous mass produced then fuses and is run off at the end of the course into suitable receptacles such as tins or drums which are then hermetically sealed.

Weirs, dams, or scraper devices may be arranged for effecting the removal or separation of impurities from the surface of the material treated or from the surface of the lead. For example, when the caustic soda liquor from electrolytic cells is treated, it may contain sodium chloride and this may be skimmed off by hand or it may be skimmed off or intercepted by one of the devices referred to. As this salt may contain caustic soda, it may be returned to the causticizing cells or inlet for further treatment, as will be readily understood.

An apparatus for carrying out the method comprises a pot or receptacle having a suitable capacity and a burner capable of operation whilst submerged in the hot liquid mass constituting the bath in the said pot, a sealed hood device being fitted in combination with the burner and adapted for carrying off the products of combustion in such a manner that these products are prevented from making contact with the treatment material which is suitably admitted to the surface of the liquid mass and drawn off after performing its course over the surface of such mass. The apparatus further comprises an inverted trough or duct, the walls of which dip into and are sealed by the hot liquid mass, this duct being adapted for directing the course of the treatment material from the admission to the delivery whilst protecting it against contact with the atmosphere or products of combustion. Finally, there is combined with the submerged burner a circulator device adapted for promoting the circulation of the hot liquid mass by the air-lift action of the combustion gases.

In order to enable the invention to be readily understood, reference is made to the accompanying drawings illustrating one

suitable practical construction, in which drawings:—

Figure 1 is a central vertical section of a pot or receptacle constructed and fitted with various devices in accordance with these improvements and particularly adapted for the treatment of caustic soda.

Figure 2 is a horizontal section on the line II—II of Figure 1.

Figure 3 is a horizontal section of a fragment, the section being taken on the line III—III of Figure 1.

Figure 4 is a vertical irregular section of a fragment, the said section being taken on the line IV—IV of Figure 2.

Figure 5 shows the upper end of a pot, such as is illustrated in the preceding figures, this pot being mounted over a rotatory furnace grate and fitted with mechanical means for the raising and lowering of the cover and associate parts, the casing of the furnace being broken away to show a portion of the furnace grate.

Figure 6 shows more or less diagrammatically in vertical section a modified construction in which the liquid is treated in a lateral extension of the pot, and

Figure 7 is a sectional plan thereof.

Referring to the drawings a is a pot or receptacle adapted for containing a charge of hot liquid mass such as molten lead, the level of the charge to be approximately at the line X—X in Figure 1. It will be seen that the upper part of the pot is of larger diameter than the lower portion. The charge may be melted or kept molten by an external furnace in which case the pot may have external fins a' for distributing the heat. Heating during the operation is performed by an internal burner hereinafter described which is employed for producing circulation of the molten mass. A circulation tube b is supported vertically and centrally within the pot a by means of a ring c seated on a ledge and suitable radial webs c' within the ring c. The upper portion of the tube b extends through a tray device d supported by the webs c', this tray being disposed at a suitable distance above the bottom of the larger diameter portion of the pot. On the tray d there is an upstanding cylindrical wall e formed with ports f around its lower part. The top of the pot is closed by a lid or cover g formed with a central removable portion g', this cover being formed with an outer depending flange or skirt g^2 which seats itself upon the shoulders of internal projecting webs h on the upper portion of the wall of the pot. The cover g is also formed or fitted with an inner concentric depending skirt or wall g^3 and between the outer and inner walls g^2 g^3 there is formed or fitted an intermediate skirt or wall g^4. Referring to Figure 2, it will be seen that one end of the intermediate wall g^4 is joined at g^5 to the inner wall g^3 and that the other end thereof is joined at g^6 to the outer wall g^2. Assuming that j in Figure 2 represents an inlet for caustic soda or material to be concentrated or dehydrated, and that k represents an outlet, it will be seen by following the arrows that the wall g^4 in conjunction with the walls g^2 and g^3 provides a sort of spiral duct leading from the inlet j to the outlet k and covering practically the whole of the annular area enclosed between the concentric walls g^2 and g^3.

It may be convenient at this point and before describing further details of construction, to describe the general mode of operation. Let it be assumed that on the surface of the bath at the level X—X there rests a layer of caustic soda up to the level Y—Y and that suitable means are provided for admitting caustic soda at j and running it off at k. Also, let it be assumed that any convenient burner is applied internally for heating the pot and keeping the lead in a molten condition. The aeration of the molten metal by the combustion gases lightens the column in the tube surrounding the burner and the molten lead will circulate by passing up the central tube b and overflowing the upper edge thereof and descending on to the tray d. The stream of lead passes quietly through the ports f in the cylindrical wall e so that a quiescent layer of molten lead is maintained over the outer portion of the tray d, there being a constant flow over the peripheral edge of the tray d and downwards beneath the latter to the well portion of the pot from which the stream ascends through the tube b as aforesaid. The caustic soda, which may be admitted at j in the form of a 50% solution obtained from an electrolytic process for example, is constrained by the walls g^2, g^3, g^4 which dip into the lead to flow over the quiescent layer of lead overlying the tray d and to take the spiral or circuitous course from the inlet j to the outlet k, the performance of this course taking the caustic soda over a large portion of the area of the quiescent layer of lead. The final concentration in any treatment may be predetermined by providing for an appropriate length of course or by appropriately regulating the rate of flow of the treatment material in performing the course. The heat of the lead first dehydrates the caustic soda and afterwards melts it, so that the caustic soda arrives at the outlet k in a molten condition in which it is run off and charged into suitable containers. Steam and vapours released from the caustic soda solution follow the course of the caustic soda and escape through an exhaust indicated at n in Figure 2, this exhaust n being disposed just in advance of the outlet k for the dehydrated caustic soda. It will be seen, therefore,

that the process is continuous and that, owing to the uniformity of heating possible with the body of lead employed, a uniformly dehydrated body is obtainable from the outlet the whole operation being carried out in an expeditious and economical manner.

The employment of a submerged burner is very advantageous for the carrying out of the process, the products of combustion therefrom acting to lighten the liquid column in the tube *b* and therefore promoting active circulation of the liquid mass. In the use of such burner it is necessary to provide for the carrying off of the gases of combustion without the possibility of such gases having contact with the caustic soda or material undergoing treatment. In the drawings, *o* indicates a burner tube or combustion tube which is formed or fitted centrally of the cover part *g'* and possesses a length sufficient for enabling it to depend into the bath well beneath the surface thereof. It will be noticed that the annular bell-like cover part *g'* extends well over the area enclosed by the cylindrical wall *e*. At one side or on three sides of the pot *a* as shown in Figure 2, there is a pipe connection *l* and from this connection there extends inwardly into the pot a duct *m* which is bent to pass upwardly through an aperture *p* in the tray *d*. The upper and inner end of the duct *m* opens beneath the bell-like cover part *g'*. The inner wall or skirt g^3 is at each of these three points formed with a bulge *q*, Figure 2, to accommodate the duct *m*. It will now be seen that products and gases of combustion from the submerged burner will pass up the tube *b* with the rising current of molten lead or other liquid and will separate from the latter within the cylindrical wall *e*. The said gases and products then pass upwards into the cavity of the cover part *g'* and so escape through the duct *m* and a suitable pipe connected with the connection *l*. Owing to the lower parts of the walls *e* and g^3 being sealed by the liquid mass, it is not possible for the gases and products of combustion to have access to the layer of caustic soda floating on the surface of the bath. A deflector or cowl formation *r* may be formed around the tube *o*, this deflector *r* being intended for deflecting downwardly any splashes or particles which may be driven upwardly by aeration and thereby preventing any escape of the hot liquid or molten lead with the gases of combustion.

In Figure 1, *s* indicates suitable fastening means for securing the removable central cover portion *g'* down upon the cover portion *g*. In Figure 5, it will be seen that the pot *a* is supported over a revoluble furnace grate *t* and that alongside the pot and grate there is erected a crane device *u* by which the cover *g g'* can be raised and lowered. As aforesaid, a revoluble grate enables the furnace to be fired through a single door, and the provision of this external heating means in addition to the internal heating means represented by the submerged burner is advantageous, as the furnace can be used for the preliminary heating of the bath to the molten condition, or it can be used as an auxiliary heating means when the burner is in action.

The inlet and outlet means for the caustic soda will now be described with reference to Figures 2 and 4. Comparing these figures, it will be seen that *j* in Figure 2 represents the orifice at the upper end of a bent duct *v* extending from the exterior through the floor of the large upper portion of the pot *a* and upwardly to such an extent that the orifice *j* is situated within the inlet end of the spiral duct formed by the walls, g^3 g^4, and above the normal level of the caustic soda therein as represented by the line Y—Y. It will be noticed that a flanged aperture *w* is formed in the tray *d* for the upward passage of the duct *v*. The caustic soda is supplied to the duct *v* under a sufficient head or pressure to cause it to rise in the duct *v* and overflow the edge at the orifice *j*. It will also be seen that *k* in Figure 4 represents the orifice at the upper end of a bent duct *x* also extending through the floor of the large portion of the pot *a* and upwardly to such an extent that the orifice *k* is situated within the outlet end of the said spiral and about at the normal level for the caustic soda. The mouth of the duct *x* may be fitted with an apron or liner *y* of a non-corrodible metal or material. This apron *y* may be adjustable up or down on the duct *x* by means of an adjusting screw *z* in order that the height of the weir or overflow edge at the outlet may be varied to suit different conditions.

In Figures 1 and 2, 10 indicates a flue for the escape of the products of combustion from the revolving grate furnace.

In the modification shown in Figures 6 and 7 the pot *a* is formed with a lateral extension constituting a sort of trough 2 open at one end to the said pot. A horizontal partition 3 projecting from the cylindrical wall *e* extends to near the outer end of the trough 2 and through this partition passes a pipe 4 for the inlet of caustic soda or the like to be treated. Hot liquid or molten metal which is heated in the pot *a*, in the manner previously described, flows over the top of the circulation tube *b*, and through a port or ports 5 in the wall *e* to the space above the partition 3. The hot liquid flows over the end of the said partition and returns beneath the latter to the

pot *a* and circulation tube *b*, as will be readily understood.

Within the trough 2 is a lid or cover 6 having a skirt 6ª, the lid or cover being supported in such a manner that the lower edges of the skirt project below the level X—X of the liquid mass. The cover is provided with duct 7 for the outlet of the caustic soda or the like after treatment during its flow over the liquid mass from the inlet 4 to the said outlet 7. Thus the caustic soda or the like is subjected to a prolonged treatment whilst flowing from the inlet to the outlet.

The lid or cover 6 and/or the partition 3 may be provided with baffles to cause the caustic soda or the like to flow in a zig-zag or tortuous stream through the trough.

The caustic soda solution may be preheated in a waste heat boiler before being admitted to the apparatus hereinbefore described. For example, a boiler may be provided through the flues of which are passed the products of combustion from the heaters of the pot and the steam and vapours released during the treatment of the caustic soda.

The apparatus may be constructed of cast steel or other suitable material not easily affected by the caustic soda or other material to be treated. In the case of caustic soda, the parts likely to be affected by contact may be nickel plated. The apparatus hereinbefore described can be modified without departing from the invention. For example, the means for obtaining the spiral, circuitous or elongated course of the caustic soda over the bath may be different from those described and illustrated.

Apparatus as hereinbefore described is operated continuously to produce caustic soda in the dehydrated condition and one small apparatus is capable of producing more than can be produced by a battery of several large ordinary open caustic soda pots which can only be operated intermittently.

I claim:—

1. A process for the heat treatment of materials, which comprises conducting the material over the surface of a hot liquid mass heated directly by the flame or gases of a submerged flame burner, and withdrawing the products of combustion at a portion of the surface which is not covered by the material in the performance of its course over the hot liquid.

2. A process for the heat treatment of materials, which comprises heating a liquid mass by means of a burner having its nozzle submerged in the mass, withdrawing the products of combustion from a sealed and enclosed space over the mass, and conducting the material over an elongated or circuitous course on the surface of the mass.

3. A process for the heat treatment of materials, which comprises heating a liquid mass by means of a burner having its nozzle submerged in the mass, and conducting the material to be treated over a covered portion of the surface of said mass, the covering being sealed by the liquid mass against the atmosphere and against the gases of combustion.

4. A process for the heat treatment of materials which comprises conducting the material over a covered path on the surface of a hot liquid mass, heating said mass directly by a burner submerged in said mass, actively circulating the hot mass by an air-lift action produced by gases of combustion, and withdrawing the gases of combustion at a portion of the surface of said mass which is not covered by the material in the performance of its course over the said mass.

5. An apparatus of the character described, comprising a pot for containing a charge of a hot liquid mass, inlet and outlet ducts for the treatment material to be conducted over the hot liquid mass, said ducts adapted for preserving a predetermined layer of the material in flotation on the hot mass in the pot, a submerged flame burner extending into the hot liquid mass within the pot, and a sealed hood or the like adapted for carrying off the products of combustion and preventing them from making contact with the treatment material.

6. An apparatus of the character described, comprising a pot for containing a hot liquid mass, a submerged flame burner extending into the said mass, inlet and outlet ducts for the treatment material, an inverted trough having its side walls depending into the hot liquid mass and adapted to form a covered and circuitous path for the treatment material, and a sealed hood for carrying off the products of combustion.

7. An apparatus of the character described, comprising a pot for containing a hot liquid mass, a submerged flame burner extending into the said mass, inlet and outlet ducts for the treatment material, a cover for said pot, walls depending from said cover and adapted to extend into the hot liquid mass, and a sealed hood for carrying off the products of combustion.

8. An apparatus of the character described, comprising a pot for containing a hot liquid mass, a submerged flame burner extending into the said liquid mass, a sealed hood for carrying off the products of combustion from said burner, an inverted trough having its side walls depending into the hot liquid mass, and inlet and outlet ducts extending through the side walls of the pot and into respective ends of the inverted trough.

9. An apparatus of the character de-

scribed, comprising a pot for containing a hot liquid mass, a submerged flame burner extending into the hot liquid mass, a nozzle on said burner, a sealed hood for carrying off the products of a combustion from said burner, a circulator tube submerged in the hot liquid mass and surrounding said burner nozzle, and sealed means for constraining the treatment material to flow over a defined portion of the surface of said hot mass.

10. An apparatus of the character described, comprising a pot for containing a hot liquid mass, a submerged flame burner extending into said mass, a sealed hood for carrying off the products of combustion, a circulator tube submerged in said mass and surrounding the nozzle of said burner, an annular tray encircling said tube, and sealed means for constraining the treatment material to flow over a defined portion of the surface of said hot mass.

11. An apparatus of the character described comprising a pot for containing a hot liquid mass, a submerged flame burner extending into said mass, a sealed hood for carrying off the products of combustion from said burner, a circulator submerged in said mass and surrounding the nozzle of said burner, an annular tray encircling said tube, radial supporting webs on said tray and tube, and sealed means for constraining in the treatment material to flow over a defined portion of the surface of said hot mass.

12. An apparatus of the character described, comprising a pot for containing a hot liquid mass, a cover for said pot, a submerged flame burner mounted in said cover and extending into said hot mass, a liquid sealed chamber formed in said cover, means for removing products of combustion from said chamber, walls depending from said cover into said mass to form a circuitous and sealed path for the treatment material, and inlet and outlet ducts for said material.

13. An apparatus of the character described, comprising a pot for containing a hot liquid mass, a submerged flame burner extending into said hot mass, a sealed hood for carrying off the products of combustion of said burner, guiding means for conducting treatment material over a defined portion of the surface of said hot mass, inlet and outlet ducts for said material, and an adjustable weir device on the outlet duct.

14. A process for the concentration or dehydration of caustic soda or other material comprising the conduction of a stream of the caustic soda or material over a circuitous course on the surface of a hot liquid or molten mass which is heated and circulated by means of a submerged burner.

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